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Abstract

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INSTRUCTIONAL OBJECTIVES FOR A JUNIOR COLLEGE COURSE IN GEOLOGY

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JC 690 409

GEOLOGY OBJECTIVES: SET # 1

CHRONOLOGICAL ORGANIZATION

CONTENT AND OBJECTIVES

Section A

Unit 1. (2½ hours)

a. The structure, methods and terms of a scientific discipline
Given a list of five common topics, statements and names, the student will state whether each is principle, theory, phenomenon, hypothesis or law; and will rank them in the hierarchy of a scientific discipline.

b. The usual simple mathematical and physical conventions
Given a list of mathematical statements applicable to Geology, the student will rearrange each statement in terms of a required variable.

c. The relations of existing scientific disciplines to each other
Given a list of observable phenomena, some of them in terms of numbers, the student must assign each phenomenon to its appropriate discipline.

d. The sources of some current ideas about cosmogeny
From a list of magnitudes, formulae and statements, the student will select those items pertinent to the evolution of matter and stellar bodies.

e. The outstanding hypotheses about the origin of the solar system and the earth and some of their shortcomings
The student will identify a series of proposed origins of the solar system with their authors. Given the angular momentum of the sun, the student will calculate the angular momentum of the solar system.

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The student will correctly write the title and name of the author of the most important reference for this unit.

Unit 2. (4 hours)

a. The position in space of the solar system
Given the distance in light years to the nearest star and to the nearest galaxy, the student must recalculate these distances in miles.

b. The dimensions and composition of the sun
From a permutation of the relative abundance of elements in the sun, the student will select the correct order. Given the sun's diameter, the student will calculate its circumference in miles and compare it with that of the earth.

c. The physical characteristics and arrangements of the planets
The student must construct a graph showing the size and densities of the planets as a function of their distances from the sun.

d. The asteroids
The student will invoke Bode's law to explain the position of the asteroids in the solar system.

e. The dimensions and shape of the earth
Given a sketch of Eratosthenes' calculation of the circumference of the earth, the student will label the appropriate parameters. The student will calculate the precision of this estimate.

f. The earth's fields: gravitational and magnetic
From a series of solutions to Newton's law of gravitation, the student must select the one correct in terms of the universal constant. Given a magnetic heading, the student must calculate the corresponding azimuth.

g. The earth's movements and their daily and seasonal consequences
Advised that he is standing on the North Pole, the student must decide in which sense the earth is rotating. Given a map of the world, the student must locate the solstices and equinoxes.

h. The nature of our satellite and those of other planets
Given a series of incomplete statements about the composition of the moon, the student must supply the correct word or phrase to make each one a plausible idea.

The student will correctly write the title and name of the author of the most important reference for this unit.

Unit 3. (2½ hours)

a. The atomic nature of matter and the simplest ideas of chemical bonding
Given a list of the chemical compositions of some naturally-occurring substances, the student will state whether the bonding of each substance is covalent, ionic or metallic.

b. The states of matter and the phenomenon of crystallinity
On an unlabeled phase diagram of a substance, the student must place an "s", "l", or "g", according as the phase is solid, liquid, or gaseous. From a list of naturally-occurring substances, the student must select the ones that are crystalline.

c. The chemical and crystalline description of the common minerals and their simple physical properties
The student must supply the proper chemical composition for each of a series of minerals. Given only the description of the symmetry and physical properties of a common mineral, the student must correctly identify it.

d. The simplest views of the conditions for stability of common minerals: mineral reactions
Given a phase diagram with the boundary between two stable mineral assemblages, the student must formulate the reaction which takes place at the boundary and balance it.

e. The three types of common rocks as mineral aggregates and their field identification.
On the basis of the description of very common rock in terms of its minerals, texture, density and mode of occurrence, the student will identify it as sedimentary, igneous or metamorphic, and give its ordinary name.

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The student will correctly write the title and name of the author of the most important reference for this unit.

Unit 4. (2½ hours)

a. The overall density of the earth
From a table of earth constants, the student must calculate the earth's average density and compare this with the density of surface rocks. Given the earth's moment of inertia, the student must compare this value with that of a homogeneous sphere.

b. The seismological properties of crystalline substances
The student will correctly solve mathematical statements for the velocity of comressional and shear waves in crystalline substances to find their rigidity and bulk moduli and densities.

c. The layered structure of the earth and the evidence from earthquakes
Informed that a given circle represents a section through the earth, and that three short line segments on the perimeter of the circle represent the initial trajectories of earthquake waves, the student must correctly prolong the linesegments to specified points elsewhere on the perimeter of the circle. Given a model corresponding to modern ideas of an earth with layered shells, the student must name each shell and list its most important chemical and physical properties.

d. The descriptions of meteorites and their possible geochemical implications
Given the description of a rock, the student will identify it as terrestrial or a meteorite, and supply its name. From a list of the descriptions of some types of meteorites the student will select those most likely to occur as "falls and name them.

e. The simplest models for the differentiation and geochemical evolution of the earth
Given the problem of a rotating sphere that shrinks to a smaller size, the student will calculate the increase in its rate of rotation. From a list of statements, the student must select those which plausibly apply to the differentiation of a homogeneous planet and arrange the statements in a chronological order.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 5 (3 hours)

a. The geochemical cycle and silica differentiation
Given a series of geochemical assertions, the student will select those which plausibly apply to the differentiation of the earth's crust and will place these in a chronology.

b. The Mohorovicic discontinuity
Given a topographic section, including a mountain range, a plateau and an ocean basin, the student will accurately sketch the base of the earth's crust according to the modern consensus. From a list of reactions, involving common rock-forming minerals, the student will select those which are favored by increasing pressure. From a list of facts concerning the seismic properties of the earth's crust, the student will select those that do not fit into the Kennedy theory.

c. The basic rock-forming processes and time sequences deduced from them
Given a cross-sectional sketch of a portion of the earth's crust showing several numbered juxtaposed rock units, the student will arrange the numbers in the correct sequence of geological events.

d. Fossils and evolution
The student will match each of a series of sketches of fossil animal remains with the name of the class or phylum to which it belongs, and assign to each a number representing its rank in an evolutionary sequence.

e. Paleontological stratigraphy
For each of a series of ideas in the development of the principles of correlating rock units by fossil content, the student must designate the name of the author, the time and place. Given three hypothetical columnar sections with descriptions of their fossil content, the student will invent a reasonable correlation in time and space.

f. The geologic column
Given the names of the most important subdivisions of geologic time, the student will arrange them in the proper hierarchy and chronological sequence. From a list of animal and plant fossils, the student will select those which best characterize any designated subdivision of geologic time.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 6 (2 hours)

a. Radioactivity
From a list of isotopes, the student will select those which have measureable half-lives.

b. Nuclear geology and geologic clocks
From a list of radioactive isotopes, the student will select those of significance to geologic dating. Given the uranium-and-thorium to lead ratio of a rock, the student will calculate its age.

c. The absolute ages of the geologic periods
Given a geologic date in years, the student will assign it to the subdivision of geologic time in which it falls.

d. The oldest dated rocks and their significance
The student, given the geological description of a locality from which an important date has been taken, will indicate both the dated rock and the oldest rock of the locality.

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The student will correctly write the title and the name of the author of the most important reference for this unit.

Section B

Unit 7 (3 hours)

a. Principles of sedimentation
The student will apply Stokes' law to explain graded bedding. Given the description of some aspect of the physical behavior of transported sediments, the student will designate the behavior by its accepted term.

b. Turbidity currents
The student will decide, on the basis of the Grand Banks data, whether an atomic submarine moves faster than a turbidity current.

c. Principles of chemical and biochemical deposition
Given a compilation of temperature-concentration curves, the student will rank the most common chemical sediments in the order of their solubility. The student will name and describe five kinds of biochemical sedimentary rocks.

d. Classification of the sedimentary rocks
Given a common sedimentary rock, the student will classify it by name, designate its origin as continental, marine, lacustrine, etc. , and assign to it a point in a silica-carbonate-clay diagram.

e. Some Pre-Cambrian sedimentary rocks
Given three unlabeled cross-sections of Pre-Cambrian localities, the student must label the Pre-Cambrian formations and name the locality.

f. Some Cambrian rocks in North America
From a geologic cross-section containing Cambrian rocks, the student will calculate the total thickness of the Cambrian section, and will designate the locality by name. From a list of marine invertebrates, the student will select those occurring in the Burgess shale.

g. Geosynclines
From estimates of deposition of clastic materials at the mouth of the Mississippi, the student will calculate its rate of subsidence. The student will correctly label the stratigraphical components on a sketch of the eugeosynclinal environment. Given a pressure-temperature diagram containing a phase transition, the student will calculate the depth at which the transition can take place.

h. The Cordilleran and Appalachian geosynclines
The student will assign to either the Appalachian or Cordilleran geosyncline each of a series of formations and stratigraphical descriptions.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 8 (2½ hours)

a. The "laws" of superposition and original horizontality
Given a geological cross-section, the student will calculate the initial dip of an indicated formation.

b. Earth forces and the principle of isostacy
The student must calculate the density of an object floating to a given depth in a medium of given density.

c. Time and the strength of rocks
The student must identify by name each of a series of different kinds of folds as shown in both map view and cross-section.

d. Folded Paleozoic rocks
Given a map of the folded Paleozoic rocks of the Appalachian belt, the student will correctly construct a block diagram of a designated portion of the map.

e. The principles of faulting and description of types of faults
The student will identify by name each of a series of faults as shown in cross-section or block diagram. Given a block diagram of a certain type of fault, the student must calculate the sense and magnitude of movement.

f. Unconformities and their significance
Given a geologic map, the student is required to trace in

red pencil all nonconformable contacts and to construct a cross-section displaying the unconformities. Given a cross-section of the Grand Canyon, the student will correctly label each formation and write its age.

g. Geologic maps and their interpretation
A geologic map containing folded and faulted formations and unconformities is presented to the student. From the map, the student will correctly sketch two indicated structure sections without taking any measurements.

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The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 9 (5 hours)

a. Sources of heat in the earth's crust
Given a series of heat-flow observations, the student will construct a heat-flow contour map of Yellowstone National Park. Given a cross-sectional diagram of the earth, the student must indicate the temperature at any given point.

b. Description of igneous processes and their related structures
Given a block diagram showing a number of igneous phenomena, the student will correctly label all indicated portions.

c. The classification of igneous rocks
Given the bulk chemical composition of an igneous rock, the student will classify it by name. The student will match the description of an igneous rock in terms of its occurrence, texture, and minerals with the proper selection from a list of rock names.

d. The simplest ideas of igneous paragenesis
The student is given a very simple temperature composition diagram, and is required to trace the cooling history of a melt of a specified composition. The student will indicate which phases are missing from an incomplete Bowen's series.

e. The genesis of igneous bodies in the light of their structural and petrological features.
Given the description of an igneous body, the student will outline its cooling history.

f. The granite controversy
From a list of field and laboratory observations upon granites, the student will indicate which favors an igneous and which a metasomatic origin.

g. The Devonian granites of New England
The student will draw a geologic sketch map of the New England granites.

h. The characteristics of extrusive rocks and the structures associated with them
Given the description in chemical and petrological terms, of an extrusive deposit, the student will indicate its geographical locality. The student must label every indicated feature of a cut-away section of a volcano and tell whether it is a shield or composite. Given data on the thickness of a pyroclastic deposit, the student will draw isopach contours upon it and indicate the prevailing wind direction.

i. The classification of extrusive rocks
For each of a series of intrusive rocks, the student will name the extrusive equivalent.

j. Permian and later vulcanism
The student is given the description of an extrusive deposit and is required to locate it in time and space.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 10. (3 hours)

a. Metamorphism and metamorphic reactions
From a list of chemical reactions, the student must select those applicable to metamorphism and balance them.

b. Metamorphic facies and the petrogenetic grid
Given a mineral assemblage, the student will assign it to a metamorphic facies. The student will cite an approximate range of temperature and pressure for a given metamorphic facies.

c. The genesis of metamorphic rocks and the structures associated with them
The student will correctly rank each of a series of mineral assemblages occurring in contact and regional terrains in their order of ascending grade.

d. The classification of metamorphic rocks
Given the description of a metamorphic rock the student must name it.

e. The Pre-Cambrian shields
The student will correctly indicate on a map of the world the stable shield areas.

f. Metamorphism in relation to the geosynclines
Given the experimental pressure-temperature curves for some metamorphic reactions, the student will calculate the minimum depth at which they can occur.

g. The Mesozoic geosynclines
The student will roughly describe the stratigraphy of the Alpine geosyncline.

Unit 11. (2 hours)

a. The present great mountain ranges and their structures
From a list of facts pertaining to the earth's great mountain ranges, the student will select those which the ranges share in common.

b. Mountain ranges of the geologic past
Given a list of the names of some important orogenies, the student will locate them in time and space.

c. The important theories of mountain-building
The student will identify mountain-building stages as belonging to the convection, phase-change, isostatic crustal-shortening, or continental drift theories.

d. The history of a mountain range
The student will assume a mountain range to be in isostatic equilibrium and given its density, the density of the substratum and the rate of erosion, will calculate its maximum elevation.

e. Present-day geosynclines
The student will be given a list of geological and geophysical observations and will select those which are given as evidence for modern-day geosynclines.

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The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 12. (3 hours)

a. The structure and origin of the Great Lakes iron formations
Given a series of oxidation-reduction reactions, the student will select (i) the reaction which correctly expresses the precipitation of iron oxides, and (ii) the reaction which correctly expresses the reduction of iron in the blast furnace.

b. The occurrence of coal
Given the map of a folded anthracite region, the student will calculate the amount of coal that can be taken in a given area by open-pit mining.

c. The genesis of petroleum and trap structures
The student must indicate which portions of a given geologic section would be favorable for the entrapment of oil and gas.

d. The nature of sulfur and salt domes
The student will construct a hypothetical structure section showing a salt dome with sulfur and anhydrite deposits.

e. Late magmatic and hydrothermal deposits
From a list of mineral formulas, the student will indicate which are late magmatic and which are hydrothermal.

f. Deposits of the precious metals and stones
The student will correctly associate a given geological environment with a given precious metal or stone.

g. The occurrence of radioactive ores
Given a list of ore minerals, the student will correctly associate and mineral with its important radioactive element and with a likely geological mode of occurrence.

h. The geochemical significance of diamonds
On the basis of a stability diagram for carbon, the student must decide at what minimum depth the Kimberly deposit originated.

i. The occurrence of, and structures related to, ground water
Given a topographic map with the locality and depth of several water wells plotted on it, the student will draw approximate contours on the water table. The student will be presented with a geologic section on which he must indicate likely places for springs. Given data on the rate of discharge of a spring, the student must calculate the permeability of the aquifer.

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The student will correctly write the title and the name of the author of the most important reference for this unit.

Section C.
Unit 13. (3 hours)

a. Geologic evidence for climates of the past
Given a list of plants and animals occurring as fossils, but having modern equivalents, the student will assign to each organism a climatic occurrence: tropical, sub-tropical, temperate, or frigid. Given a numbered list of fossil animals and plants, and a map of the modern world, the student will write the number of the fossil on the geographical locality of its occurrence.

b. A simplified model for the distribution of present-day climates
The student is presented with a simplified map of the continents and the oceans. The student will approximately delineate the climatic zones and will label each zone. For each climatic zone, the student will list two characteristic plants.

c. The stability of rock-forming minerals under atmospheric conditions
The student must calculate the weight of salt given up to the streams in the weathering of a given weight of granite. The student will correctly associate each of a series of rock types with its appropriate weathering reaction.

d. Factors contributing to the decomposition of surface rocks
The student will list five physical factors tending to the preparation of surface rocks for the forces of weathering.

e. The development of soils in relation to climatic zones
Given the sketch of a characteristic soil profile, the student must correctly label each horizon and assign the profile to a climatic zone.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 14. (2½ hours)

a. Glaciers of today - continental and montane
The student will correctly indicate on a map modern areas of glaciation. The student will correctly calculate the freezing temperature of seawater.

b. The movement of ice masses
Given a phase diagram of the system H_2O, the student will indicate the property fundamental to the movement of ice.

c. Geological features associated with glaciers
The student will correctly label each portion of a sketch showing numerous phenomena interpreted as evidence of former glaciation. The student will list three obvious glacial attributes of the scenery at Yosemite.

d. Pleistocene glaciation - recognized stages
Given a map of North America, the student will approximately delineate the maximum advance of the Pleistocene ice sheet. The student will correctly associate a given radiocarbon date with the name of the glacial or interglacial stage which includes it.

e. The aftereffects of glaciation in North America
The student is presented a map of North America with numbered localities. The student will correctly associate each number with the description of a geological feature related to Pleistocene glaciation.

f. Evidence for glaciation in the geologic past
The student will cite three areas of the world containing Paleozoic glacial deposits.

g. Theories of the Ice Age
The student will identify each of a series of the elements of the outstanding glacial theories with its author.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 15. (4 hours)

a. The classification of downslope movements and their dependence on climate and rock types
Given the description of a particular kind of downslope movement, the student will name a place in California where the phenomenon can be observed. From a list of mathematical statements, the student will select those applicable to the movement of the Blackhawk slide.

b. The significance of downslope movements in the geological process
Given a portion of a geologic map containing an angular unconformity, the student will estimate the relief of the unconformity.

c. Downslope movements and human culture
Given a geological cross-section, the student will select the most favorable location for building a house.

d. The simplest ideas of fluid mechanics
The student will correctly associate each of a series of terms - laminar flow, turbulent flow, shooting flow, etc.- with one of its most important attributes.

e. The chemistry of the dissolved load and some of its effects
Given a permutation of the abundance of ionic species in fresh waters, the student will select the correct order. The student will correctly rank each of a series of substances in the order of its solubility.

f. The mechanics of suspended load and stream erosion
For a given increase in the discharge of a stream, the student will calculate its increase in competence. The student is given the topographic section of a stream profile and required to indicate disequilibrium portions. Given the description of a series of events tending toward the equilibrium profile of a stream, the student must place them in the correct order.

g. The principles of erosion and deposition in sinuous streams
The student will correctly describe an experiment which could be used to study all the phenomena of sinuous streams.

h. Geomorphological consequences of stream erosion
The student is presented with a series of sketches of landforms and is required to associate each of these with a pertinent statement about the geology and/or climate. From a topographic map with a well-developed system of streams and tributaries, the student will derive a mathematical relation between the order of the tributaries and the number of them.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 16. (3 hours)

a. The extent and mass of the oceans
The student must calculate the pressure at the bottom of the Mindinao Deep.

b. The composition of ocean waters
The student is required to correctly calculate the weights of the five most abundant salts which would result from the evaporation of a given weight of sea water.

d. The mechanics of ocean waves and the geomorphology of ocean shores
Given a series of descriptions and/or sketches of interesting shoreline features, the student will identify each by name and correctly associate it with a geomorphological process. The student will invoke the law of conservation of momentum to explain tidal waves.

e. Submarine topography
The student is given a map of the oceans showing important details of submarine topography. The student will name all indicated features.

f. The principles of marine sedimentation
Given the description of a marine rock or sediment, the student will classify it by its oceanic environment.

The student will correctly write the title and the name of the author of the most important reference for this unit.

Unit 17. (3 hours)

a. The topographic map of California
Given a simple topographic map of California and a numbered list of prominent features, (Death Valley, Mt. Whitney, etc) the student will write the correct number for all indicated portions of the map. The student will correctly calculate the slope of the Palm Springs tramway.

b. The geologic map of California and sketch of Tertiary history
Given an unlabeled geologic map of California, the student will give the age of any designated formation.

c. California landscapes and climates
Given a photograph of a place in California, the student will correctly name the locality. The student will correctly associate each of a series of localities with a species of lizard occurring there.

The student will correctly write the title and the name of the author of the most important reference for this unit.

GEOLOGY OBJECTIVES: SET # 2

ORGANIZATION OF UNITS

This is an introductory course in physical geology covering basic geologic skills and principles, earth materials, stratigraphy, paleontology, development of landforms, internal earth processes, and economic and vocational aspects of geology.

Unit Goals and Objectives

Note: Urless stated otherwise stated, objectives are to be performed under objective test conditions (multiple choice, matching, true-false, or questions with 2 alternative answers (e. g., "X does or does not apply")) in the classroom or laboratory without the help of references, and in writing.

Unit I: Gross structure of the earth. Unit Goal: The student will have a basic knowledge of the gross structure and composition of the earth's crust and interior and the significance of the Mohorovičić discontinuity.

Objective 1: On multiple-choice test he will select the appropriate characteristics (specific gravity, composition, average thickness, whether solid, etc.) of the main regions (crust, mantle, etc.) of the earth. 75% correct.

Objective 2: On multiple-choice test he will correctly identify the known and inferred nature of the Mohorovičić discontinuity.

Objective 3: He will draw a rough sketch showing the depth of the Mohorovičić discontinuity (using figures) under the Pacific Ocean and North America including the western cordillera and the central stable region.

Unit II: The Scientific Method. Unit Goal: The student will become familiar with the scientific method of investigation and will himself be able to apply it to geologic problems.

Objective 4: Given (1) a set of facts, kinds of facts (e. g., "ammount of sorting," "compositional variations") or sources of facts and (2) the statement of a geologic problem, he will state in 75 words or less how he would go about trying to answer the question. 80% correct.

Objective 5: Given geologic problems and various ways of attacking them, he will arrange the methods in the probable order of their effectiveness, on a multiple-choice test. 75%.

Unit III: Identification and properties of the common rocks and minerals. Unit Goal: The student will be able to identify and will be familiar with the basic properties of the more common minerals and rock types and will have a basic knowledge of the principles of mineralogy.

Objective 6: Given a suite of numbered (unknown) minerals in the laboratory he will perform hardness and other tests to identify them; he will list his identifications on a lab. sheet. 80% correct. References may be used.

objective 7: Given a suite of minerals in the laboratory, he will list on the lab. sheet for each mineral its name, chemical formula, and whether it usually originates in ignous, metamorphic, or sedimentary rocks. 75% correct.

Objective 8: Given a suite of unknown rocks in the laboratory he will list on the lab. sheet the major minerals in each (75% correct), the name (80% correct), common origin (75% correct), and in what geologic environment he would expect to find each (60% correct).

Unit IV: Reading and producing geologic and topographic maps and diagrams. Unit goal: The student will be able to read, interpret, and construct topographic maps and simple geologi, maps, cross-sections, and other basic diagrams.

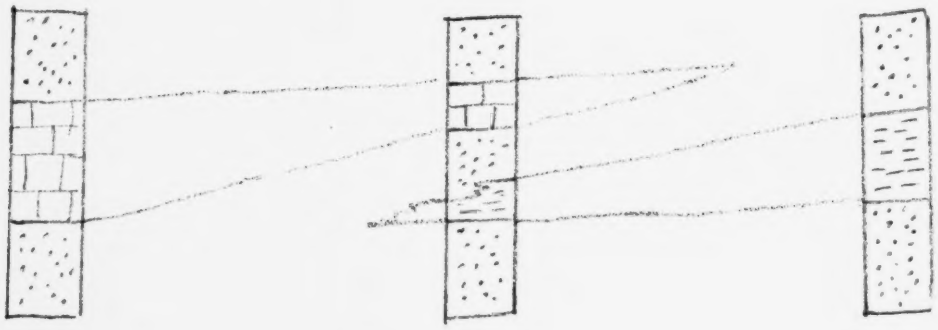
Objective 9: He will show reading ability of topographic maps by answering multiple choice questions on scale, township-range system, stream gradients, slopes, heights above sea level and other given points, points that can or connot be seen from other points on the ground, and culture on given maps. 75% correct.

Objective 10: He will interpret simple geologic maps by answering multiple choice questions and by drawing and/or completing simple block diagrams and cross-sections.

Objective 11: He will complete block diagrams and construct simple block diagrams and cross-sections from geologic maps involving fairly simple faulting and folding. 75% correct.

Objective 12: On a matching test he will correctly identify several litholcgic symbols used on cross-sections. 75% correct.

Objective 13: Given a set of simple stratigraphic columns, he will draw stratigraphic corellations between them.



Unit V: Geologic Time. Unit Goal: The student will be familiar with the concept and basic subdivisions of geologic time and the principal ways of dating rock units and geologic events.

Objective 14: Given a list of geologic eras, periods, and Cenozoic epochs he will arrange them in correct order on a matching test. 75% correct.

Objective 15: On a matching test he will identify the approximate age in years before the present of given geologic eras, periods, and epochs. 60% correct.

Objective 16: He will list at least three ways in which rock units are assigned geologic ages (e. g., upper Miocene). Examples: radiometric dating, fossils, stratigraphic relation to rocks of established age.

Unit VI: Paleontology. The student will have a basic knowledge of the principles of paleontology and its uses in geology.

Objective 17: He will match terms such as "fossil," "cast," and "mold" with appropriate described processes. 80% correct.

Objective 18: On a multiple-choice test he will identify given phenomena as factors or not factors likely to affect biological evolution. 75% correct.

Objective 19: On a multiple-choice test he will identify given suggestions as ways in which biological ivolution may or may not occur. 60%.

Objective 20: On a multiple-choice test he will interpret the ancient environment (e. g., shallow near-shore sea water near inflowing river with large silt load) of given fossil assemblages in light of given ecological data for given organisms. 60% correct.

Objective 21: He will match points or periods of geologic time and important paleontologic trends or events (e. g., Jurassic-Cretaceous: dinosaurs flourish). 65% correct.

Unit VII: Geomorphology. Unit Goal: The student will have a basic knowledge of the principles of geomorphology including the evolution of landforms and the effects of them of geologic structure, earth movements, and varieties of weathering and erosion.

Objective 22: Given drawings of various common geomorphic features he will correctly identify them by name on a multiple choice test. 70% correct.

Objective 23: Given descriptions of geomorphic-tectonic processes leading to various unnamed landforms he will select the appropriate landforms on a multiple-choice or matching test. 70% correct.

Objective 24: Given names of rock types he will, on a multiple-choice or matching test, rank them in order of resistance to weathering and/or erosion under various given climatic conditions. 70% correct.

Objective 25: He will describe correctly in 20-40 words the process by which caverns are dissolved in carbonate rock units. 75%.

Objective 26: On a matching test he will correctly identify descriptions of youthful, mature, and old-age topography. 75% correct.

Objective 27: Given columnar drawings illustrating various types of soil profiles, he will select on a matching test the appropriate climatic conditions for the formation of each.

Objective 28: On a matching test, given geologic cross-sections with specific building sites marked on them, he will rank each site on its relative safety from landsliding.

Objective 29: Given illustrations of building site preparation proceedures (e. g., cutting platform into hillside) on sites with given geologic-topographic characters, he will identify the safest and least safe proceedures on a multiple-choice test. 70% correct.

Unit VIII: Igneous Rocks and Processes. The student will have a basic knowledge of the common igneous rocks and their origins and an understanding of the more important igneous processes

Objectives 7 and 8 in more detail for ignous rocks.

Objective 30: Given magmas of various compositions he will identify by name on a multiple choice test the volcanic and plutonic rocks which would result from cooling without further differentiation. 65%.

Objective 31: Given a magma of a given composition he will identify on a multiple choice test a rock formed after further differentiation.

Objective 32: He will identify terms describing given volcanic and plutonic phenomena on a matching test. 70% correct.

Objective 33: He will match names of types of plutonic bodies with their characteristics on a matching test. 75% correct.

Unit IX: Sedimentary rocks and processes. Unit goal: The student will have a basic knowledge of the common sedimentary rocks and an understanding of their uses in interpreting geologic history.

Objectives 7 and 8 in more detail for sedimentary rocks.

Objective 34: Given a short list of sediments of varying ages, he will arrange them in correct vertical order of occurrence in a stratigraphic sequence on a matching test. 100% correct.

Objective 35: He will select the best interpretations of depositional environments of sediments based on depositional structures such as ripple marks, mud cracks, and turbidites on a multiple choice test. 60% correct.

Objective 36: Given a list of sedimentary rocks, he will match them with depositional environments. 70% correct.

Objective 37: Given stratigraphic cross sections and columns on a multiple choice test, he will pick the best interpretations of depositional, tectonic, and/or erosional history of source and depositional areas.

Unit X: Metamorphic rocks and processes. Unit Goal: The student will have a basic knowledge and understanding of metamorphic rocks and processes of metamorphism.

Objectives 7 and 8 in more detail for metamorphic rocks.

objective 38: Given the mineral composition of an original sedimentary, igneous, or metamorphic rock, he will select on a multiple-choice test the appropriate mineral assemblage or descriptive name for the metamorphic equizalent in a given metamorphic grade. 65% correct.

Objective 39: Given mineral assemblages of metamorphic rocks, he will choose on a multiple-choice test the appropriate metamorphic grade and/or the best choice of metamorphic environment (e. g., high temperature and low pressure, or contact aureole of a pluton). 65% correct.

Unit XI: Folding and faulting. Unit Goal: The student will have basic knowledge and understanding of (1) the more common kinds of folds and faults and their interpretation, causes, and effects, and (2) the causes and effects of earthquakes and ways of minimizing earthquake damage.

Objective 40: On a multiple choice test the student will match cross-sectional and/or block diagrams of folds and faults with their names and styles (e. g., anticline, dome, similar folding, normal fault). 75% correct.

Objective 41: He will match styles of folding and faulting with the best choices of stress-load-temperature conditions during folding. 65% correct.

Objective 42: He will describe with at least 80% accuracy in 60-200 words the mechanism of fault movement covering creep, buildup of stress, manner and distance of breakage, and aftershocks.

Objective 43: He will correctly identify on multiple choice questions the focus and the epicenter of an earthquake.

Objective 44: He will correctly name and describe in 10-35 words each the 3 types of earthquake waves and will indicate their relative speeds.

Objective 46: He will note correctly whether he would expect relatively heavy, average, or relatively light earthquake damage for 4 of 6 types of building sites (e. g., loose fill, bedrock).

Objective 47: He will list correctly in 20-40 words each 3 features in the design of buildings which should help to make them relatively resistant to major earthquake damage (e. g., steel frame) and will explain why they should have this effect.

Unit XII: Tectonic Synthesis. Unit Goal: The student will have a basic understanding of past and, especially present, hypotheses regarding regional and global tectonics and will be able to critically evaluate and synthesize the geologic data upon which they are based. In doing so he will develop a feeling for the nature of the science of geology and a feeling for the grand scale on which our earth, not to mention the universe, moves and changes.

Objective 48: On a matching test he will match given data (e. g., "fit" of South America and Africa) and the appropriate given tectonic hypotheses or groups of hypotheses. 70% correct.

Objective 49: Outside of class he will write a short paper (5-10 double-spaced typewritten pages or the equivalent handwritten) outlining his tectonic synthesis or supporting a previously-described one (with reasons). Use of outside reference material is encouraged; this is to be documented in footnotes on each page or in the back of the report. The purpose of the paper is to stimulate the student to synthesize, evaluate, and use a wide range of the geologic material we have covered and that which he "digs up" in references by attacking a specific problem using the scientific method; he also gains experience in finding references and finds out part of what is available. Grading will not be on "rightness" of synthesis but on the quality and level of thingking, etc. The paper is due during the last week of classes, and will not count very heavily toward the course grade since it is intended to be mainly a stimulus for the student.

Unit XIII: Economic Geology. Unit Goal: The student (1) will have a basic knowledge of the more important economic mineral resources of the earth and an understanding of their origins and the principles of their localization; and (2) will have a basic understanding of the methods of recovery of these resources.

Objective 50: The student will match given economic minerals with given modes of occurrence (e. g., placer deposit). 70% correct.

Objective 51: Given diagrams with numbered points, he will identify on a multiple-choice test likely places for petroleum accumulations.

Objective 52: He will identify on a matching test from diagrams 4 out of 6 parts of a typical mine (e. g., shaft, adit).

Unit XIV: Vocational Information. Unit Goal: The student will have a basic knowledge of the main career opportunities in the field of geology and an understanding of the activities and training associated with each.

Objective 53: Given examples of professional duties (e. g., study of seismic profiles to find buried anticlines) and geologic careers (e. g., petroleum exploration geologist) he will match them on a matching test.

Objective 54: On a matching test he will match given geologic work types and given ammounts and types of training required.